* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] the maintenance with little damage about radioactive substance storage facilities, such as a radioactive body storage container for covering the radiation which comes out of the seal object which sealed the radioactive substance, and the radioactive electric shielding structure, this invention prevents degradation of the screen by heat and external ambient atmosphere conditions in a detail, and is excellent in the radiation shielding engine performance and endurance, and according to an external load -- it is related with an easy radioactive substance storage facility.
[0002]
[Description of the Prior Art] While carrying out dismantling processing of the spent fuel aggregate generated from a nuclear power plant, in order to collect useful matter which can be again used as a fuel, such as plutonium, there is a plan to rework. Although such spent fuel has been conventionally kept primarily to the fuel assembly pool of a reactor etc. until it performs the reprocessing, there is a possibility that the stowage of storage facilities, such as a pool, may reach a limitation with the spent fuel which increases every year. Then, the facility which can keep spent fuel in the cheap condition in which ejection is possible for a long period of time is needed for insurance until it performs reprocessing.
[0003] Development of the dry process which performs natural air cooling with air as such a facility is furthered, and the low thing of operation cost attracts attention compared with the pool. Dry process is roughly classified into two with the metal cask methods similar to the approach which used the welding seal metal vessel (henceforth a canister), and a transportation canister. A canister method is divided into the vault method which covers many canisters by one storage facility further, and the silo or concrete cask method which covers one canister with the one concrete structure. Although merits and demerits are in each method, since it is low cost, the concrete cask method has attracted attention in the U.S. in recent years. Drawing 3 and drawing 4 show the outline sectional view of the horizontal and the perpendicular direction of a concrete module used for the conventional concrete cask method.
[0004] This concrete module 30 consists of a canister 31 and a concrete screen 32 fundamentally. A canister 31 is the welding seal structure which enclosed two or more spent fuel aggregates, has the structure which the radioactive substance of the enclosed interior does not reveal outside, and is formed in the shape of a cylinder. This canister 31 is loaded into the screen 32 made from cylinder-like concrete. Between the canister 31 and the screen 32, the fixed gap which forms the cooling air passage 33 is prepared. In order to introduce exterior air into this cooling air passage 33, the cooling air inlet port 34 is established in the pars-basilaris-ossis-occipitalis side of a screen 32, and the cooling air outlet 35 is established in the upper part side of a screen 32. Moreover, the metal liner 36 is formed in the inside of the cooling air passage 33 of a screen 32.
[0005] Usually, from spent fuel, it is accompanied by generating of generation of heat accompanying decay heat, and a radiation. Therefore, by this concrete module 30, cooling of spent fuel, electric shielding of a radiation, and the seal engine performance of the radioactive substance are needed. By the

concrete cask method, cooling is the air which flows the cooling air passage 33 between a canister 31 and a screen 32, electric shielding is a screen 32 and seal is collateralized with a canister 31. Moreover, the reinforcement of the concrete module 30 is also collateralized by the screen 32. Here, in that the radioactive substance is not revealed outside by any means in seal, that it is below the reference value with which the dose the inside of a storage activity and outside a facility was specified to law by electric shielding, and cooling, to make it neither the skin temperature of a canister nor the temperature of the screen 32 made from concrete have a bad influence on the description of a canister or concrete is demanded throughout [storage term].

[0006] By the way, it is the factor as for which a temperature gradient [in / although an outside surface is ordinary temperature in the screen made from the conventional concrete, an internal surface serves as an elevated temperature with the decay heat from spent fuel, and / an inside-and-outside front face] becomes large, thermal stress (it is tensile stress at the compressive-stress and periphery section in the inner circumference section) acts, and the tensile stress in the periphery section becomes larger than the tensile strength of concrete in many cases and which a crack generates in the periphery section for this reason. Endurance and the radiation shielding engine performance fell and the screen which the crack generated too much had a problem of stopping being suitable for use. In order to prevent the effect of the crack by this heat, there is the approach of carrying out presto rest installation as a well-known technique, and canceling the tensile force by thermal stress. Moreover, the structure which arranges a heat pipe between a canister and a screen in a thermal insulation plate or the electric shielding inside-of-the-body section is indicated by JP,7-27897,A and the 8-43591 official report. In such structure, although the prestress installation method of construction is technically possible, are high cost, according to a thermal insulation plate or the heat pipe, it is expectable to suppress the rise of the internal temperature of a concrete screen to some extent, but It is difficult to prevent the long term deterioration (carbonation, permeation of salinity, etc.) of the concrete which advances from the crack generated in the outside surface of a concrete screen by the drying shrinkage of the degree difference of inside-and-outside surface temperature, or concrete, or an outside surface, and there was a problem of being high cost, further.

[0007] Although the moisture in concrete is gradually lost by desiccation and the shielding effect over a neutron beam is a long-term span not only in the problem of degradation by such temperature gradient but in the conventional radioactive substance storage facility made from a reinforced concrete since a concrete screen is put on the bottom of hot environments, there is a common problem of falling by the passage of time. For this reason, by low cost, there is no electric shielding performance degradation over a long period of time, and it excelled in endurance, and was anxious for the radioactive substance storage facility excellent also in the safety to the load from the outside further.

[0008]

[Problem(s) to be Solved by the Invention] When this invention is made in view of such a background and the purpose of this invention prevents effectively a crack which affects the activity electric shielding engine performance of a concrete screen, and loss of moisture, it is in offering the radioactive substance storage facility could maintain radiation shielding capacity over the long period of time, and the damage by the outside load excelled [storage facility] in little endurance.

[0009]

[Means for Solving the Problem] Wholeheartedly, as a result of examination, this invention persons are covering the peripheral face of a cylinder-like concrete screen with liners, such as a steel plate, and arranging the diaphragm for temperature crack induction near the periphery section, and completed a header and this invention for the ability of said problem to be solved. Namely, the radioactive substance storage facility of this invention surrounds the outside of the seal object which sealed the radioactive substance by cylinder-like the screen made from concrete. In the radioactive substance storage facility which removes the heat with which airstream close space is prepared between this seal object and this screen, and the radioactive substance generates the interior of this airstream close space with the flowing air It is characterized by coming to arrange the diaphragm of the configuration where it was crooked for covering the periphery of the screen made from concrete of the shape of this cylinder with liners, such as

steel materials, and inducing a temperature crack near [the] the periphery.
[0010] While according to this invention the liner which covers the periphery of the screen made from concrete plays the role which restrains internal concrete and can aim at improvement in on the strength, loss of the moisture from a concrete front face can be controlled by preparing an enveloping layer in the periphery section, and the fall of a shielding effect to the neutron beam accompanying loss of moisture can be prevented. Furthermore, a temperature crack is made to induce along with this diaphragm by arranging the diaphragm of the configuration where it was crooked for inducing a temperature crack, near the periphery of a cylinder-like the screen made from concrete, and while being able to prevent a penetration crack which affects the radiation shielding engine performance, transparency of the radiation passing through between cracks can be prevented. In the radioactive substance storage facility of this invention, while giving the role which restrains internal concrete to liners, such as a metallicity liner which covers the periphery section of a cylinder-like the screen made from concrete, as a membrane structure element, it is desirable to take the mode which raises the resistance over external loads, such as an earthquake, by arranging the reinforcing bar of a circumferencial direction and the direction of a vertical in the inside field of a cylinder-like the screen made from concrete further.
[0011]
[Embodiment of the Invention] Below, this invention is explained at a detail. The radioactive substance storage facility of this invention is constituted from a screen made from concrete of the shape of a cylinder which comes to cover with a liner the periphery front face arranged on the outside of the seal object which sealed the radioactive substance, and an up-and-down disk. The metal liner which prepares airstream close space between this seal object and this screen, removes the heat with which the radioactive substance generates the interior of this airstream close space with the flowing air, and constitutes a cylindrical screen, Structure which resists external force, such as an earthquake which acts on the thermal stress and the radioactive substance storage facility by the degree difference of inside-and-outside surface temperature of a concrete screen, with the concrete which prepared the reinforcement structure by reinforcement in the interior preferably is realized.
[0012] Hereafter, with reference to a drawing, the mode of this invention is explained concretely. Drawing 1 and drawing 2 show the horizontal schematic diagram of the radioactive substance storage facility 10 concerning the gestalt of operation of the 1st of this invention, and a vertical outline sectional view. This radioactive substance storage facility 10 consists of a canister 11 and a concrete screen 12. The canister 11 is cylindrical and the radioactive substance is sealed inside.
[0013] The screen 12 made from concrete consists of cylinder partial 12a made from the reinforced concrete covered with the liner 13 in the periphery front face, heavy-gage disk (lower lid) 12b which supports this, and top-cover 12c of a canister carrying-in outlet. The gap between the bore of a screen 12 and the outer diameter of a canister 11 functions as cooling air passage 14.
[0014] Although the liner which comes to twist the band-like resin plate and band-like metal plate reinforced with Plastic solids, such as metal plates, such as a well-known thing, for example, a steel plate etc., high intensity engineering plastics, and fiber reinforcement plastics, the carbon fiber, the high intensity polyamide fiber, etc. as a liner 13 used for a periphery can be used choosing it suitably, if reinforcement and endurance are taken into consideration, steel plates, such as structural rolled steel and rolled steel for welded structure, etc. will be mentioned preferably. Moreover, although there is especially no limit in the thickness of a liner, when using a steel plate, from the viewpoint of effectiveness and economical efficiency, generally it is desirable that it is the range of 5-20mm, and the range of 10-15mm is still more suitable. If too thick [if the thickness of a liner 13 is too thin, the strong improvement effectiveness will become inadequate, and], it is not desirable from a viewpoint of economical efficiency.
[0015] The unit or two or more cooling air passage 15 for opening the electric shielding outside-of-the-body section and the cooling air passage 14 for free passage are formed in the screen 12 bottom. The cooling air passage 15 by the side of this entry consists of the 1st horizontal level formed at a level with an outside, a vertical section extended upwards from the edge inside the 1st horizontal level, and the 2nd horizontal level extended at a level with the inside from the top edge of a vertical section. the top face of

the 1st horizontal level -- the same flat-surface top as the inferior surface of tongue of the 2nd horizontal level -- or it is located in the inferior-surface-of-tongue bottom of the 2nd horizontal level, the radiation which passed along the 2nd horizontal level by this is reflected on the wall surface of a flection, and it reveals outside. In addition, each horizontal level may incline upwards as it becomes inside. Two or more projections which are not illustrated are formed in the interior above the cooling air passage 15 of the entrance side of a screen 12, and a canister 11 is supported by the screen 12 by this projection.
[0016] Moreover, the cooling air passage (outlet side) 16 is formed in the location which counters the cooling air passage (entrance side) 15 formed in the screen bottom in the upper part of a screen 12. This cooling air passage (outlet side) 16 consists of the 1st horizontal level formed at a level with the inside, a vertical section extended upwards from the edge of the outside of the 1st horizontal level, and the 2nd horizontal level extended at a level with an outside from the top edge of a vertical section. the top face of the 1st horizontal level -- the same flat-surface top as the inferior surface of tongue of the 2nd horizontal level -- or it is located in the inferior-surface-of-tongue bottom of the 2nd horizontal level, the radiation which passed along the 1st horizontal level by this is reflected on the wall surface of a flection, and it reveals outside. In addition, each horizontal level may incline upwards as it becomes outside. The liner 13 is attached inside such cooling air passage (inlet port) 15 and the cooling air passage (outlet side) 16. In addition, since degradation by the temperature rise of a screen 12 is controlled, heat insulators, such as a ceramic system, can also be installed in the liner 17 of the inner skin which faces a canister 11 if needed.
[0017] Cooling air is introduced into the electric shielding inside-of-the-body section bottom from the cooling air passage (inlet port) 15, in case it passes through the cooling air passage 14, it cools the canister 11 with which it was loaded into the screen 12, it goes up the electric shielding inside of the body by the free convection, and is exhausted from the cooling air passage (outlet side) 16. In this process, while the decay heat which comes out of the radioactive substance in a canister 11 is discharged outside by the free convection of the air passing through the cooling air passage 14, a part of decay heat is transmitted to the concrete which constitutes the screen 12 made from concrete. According to this invention, since the moisture in concrete does not carry out the fly off of it outside while the front face of cylinder-like screen 12made from concrete ** a is covered by the liners 13, such as a steel plate, and can prevent the fall of the endurance by carbonation of concrete, invasion of coming-flying salinity, etc., the electric shielding performance degradation to a neutron beam etc. can be prevented.
[0018] In this mode, the folding screen-like diaphragm 18 is installed in radial [cylindrical] near the liner 13 which covers the periphery front face of cylindrical screen 12a. By inducing a temperature crack along with the diaphragm 18 of this crooked configuration, linear transparency of the radiation which let between cracks pass can be prevented, and the electric shielding engine performance can be secured. As for this diaphragm 18, it is desirable to install so that the division-into-equal-parts rate of the body 12a may be carried out to a hoop direction, and the numbers of installation parts are not 6 thru/or the thing restricted to this, although about eight places are considered to be suitable. In addition, although the folding screen-like thing is used for the configuration of a diaphragm 18 in this mode If it has the crooked configuration, as long as it has the magnitude of extent to which the radiation emitted from a canister 11 does not penetrate a temperature crack to the temperature crack of the concrete which may be produced near the diaphragm There is especially no limit in the configuration, and it can choose the shape of a wave, the shape of a folding screen, and the configuration of the crooked arbitration equivalent to these as it. If these are taken into consideration, as for a diaphragm 18, it is desirable that the thickness of about 10-20mm and the pitch of crookedness are about 100-300mm.
[0019] Moreover, it is desirable to prepare irregularity in the front face of a diaphragm 18 in order to prevent the gap with a diaphragm and concrete and to aim at transfer of the shearing force of concrete. As a mode of this irregularity, the mode which prepares disc-like heights with 5-10mm [in thickness] and a diameter of about 20-30mm in about pitch 50mm on the surface of a diaphragm is mentioned, for example. If the electric shielding engine performance to the irregularity and the processing ease of a crookedness configuration to form, the workability at the time of radioactive substance storage facility construction, and various radiations is taken into consideration as the quality of the material of a

diaphragm 18, it is appropriate to use minerals ingredients, such as cement system molding plates, such as fiber reinforcement mortar, and a ceramic system molding plate. Moreover, it is also possible to use the steel plate in which the shape of predetermined toothing was formed.

[0020] In this mode, in order to secure reinforcement, the configuration of the screen of a reinforced concrete construction is adopted, and in the inside field of cylinder-like concrete screen 12a, the reinforcing bar 19 of a circumferencial direction and the reinforcing bar 20 of the direction of a vertical are arranged. Thus, what is necessary is just to form reinforcing bars 19 and 20 near the inner circumference section, while arranging a diaphragm 18 near the periphery section of cylindrical screen 12a and aiming at prevention of a crack, as shown in drawing 2 in arranging the diaphragm 18 of a crookedness configuration to cylindrical screen 12a of a reinforced concrete construction. By considering as such structure, body 12a can be used as a resistance element to earthquake force. Moreover, the drag force to a crack or external force can be raised by giving the role which restrains internal concrete by using the liner 13 of a screen 12a periphery section front face as a membrane structure element.

[0021] By considering as such structure, the outside field of concrete screen body 12a contributes mainly to electric shielding of a radiation, and an inside field turns into a field which has two functions of electric shielding of a radiation, and the resistance element in case of an earthquake. What is necessary is just to decide suitably these partitions, i.e., the die length and the number of arrangement of a diaphragm 18, the reinforcement (a size, quality of the material) of a reinforcing bar, the location of arrangement, and an arrangement pitch according to the temperature conditions which a concrete screen receives, or the earthquake-proof ability which should be given.

[0022] Here, the manufacture approach of this screen 12made from cylindrical concrete a is explained. In case cylindrical screen 12a is formed, use said liner 13 and metal liner 17 as shuttering, and the reinforcement 19 and 20 for reinforcement is arranged inside. The metal liner 17 of the inner circumference section, and the liner 13 of the periphery section For example, the concrete for fixing so that it may have fixed spacing by a tie rod etc., and forming a screen into it by using as shuttering the duplex cylinder formed at this liner 13 and the metal liner 17 is placed and stiffened, and cylinder-like screen 12made from concrete a is manufactured. At this time, the unification with a diaphragm 18 and internal concrete can be attained by arranging a diaphragm 18 beforehand inside. According to this approach, since a liner 13 and the metal liner 17 serve as the shuttering at the time of concrete placing, a shuttering ingredient becomes unnecessary and compaction of the time necessary for completion can also be attained.

[0023] As concrete which constitutes the screen 12 of this invention, a well-known thing can be used suitably, after carrying out the sequential injection of cement, and a fine aggregate and coarse aggregate and carrying out interspace kneading to a mixer several seconds as the manufacture approach, for example, if needed, additives, such as cement distribution material and a water reducing agent, are added with water, it kneads and the method of placing and manufacturing the concrete constituent of the shape of an acquired paste to shuttering is mentioned.

[0024] Here, as usable cement, various blended cement, such as Portland blast furnace cement besides various Portland cement, such as cement, an early strength cement, and moderate heat Portland cement, fly ash cement, and silica fume cement, can usually be used. Moreover, minerals fine particles, such as ground granulated blast-furnace slag, silica stone powder, limestone powder, and silica fume impalpable powder, can also be added and used for these cement in the range which does not spoil the effectiveness of this invention if needed.

[0025] In addition, since expansion is restrained by the surrounding liner by using the concrete which has expansibility at the time of coagulation on the occasion of manufacture of a concrete screen, compressive force is introduced into a concrete screen and it is effective for temperature crack prevention or reduction. The expansive concrete which added the inflating agent which uses alumina powder as a principal component as concrete with such expansibility is mentioned.

[0026] Since a radioactive substance storage container front face is covered with a liner and a concrete side is not exposed as an advantage of said embodiment, Since there is little damage and it does not

expose a crack, either, even if it receives external loads, such as an earthquake, since endurance improves and a liner exists in a peripheral face, Since the point that possibility that it can be used succeedingly is large, and the whole storage container are covered with the liner even after disaster, such as an earthquake, happens, Since maintenance and maintenance are paint extent of a periodical steel plate, it ends and the fly off of the moisture in concrete is prevented by the liner on the point that a maintenance is easy, and the front face of a periphery, the point that the shielding effect over a neutron beam etc. is maintained over a long period of time etc. is mentioned.

[0027]

[Effect of the Invention] the maintenance which according to the radioactive substance storage facility of this invention prevented degradation of the concrete screen by generation of heat of a canister, and was excellent in endurance or the electric shielding engine performance over the long period of time -- an easy radioactive substance storage facility can be built.

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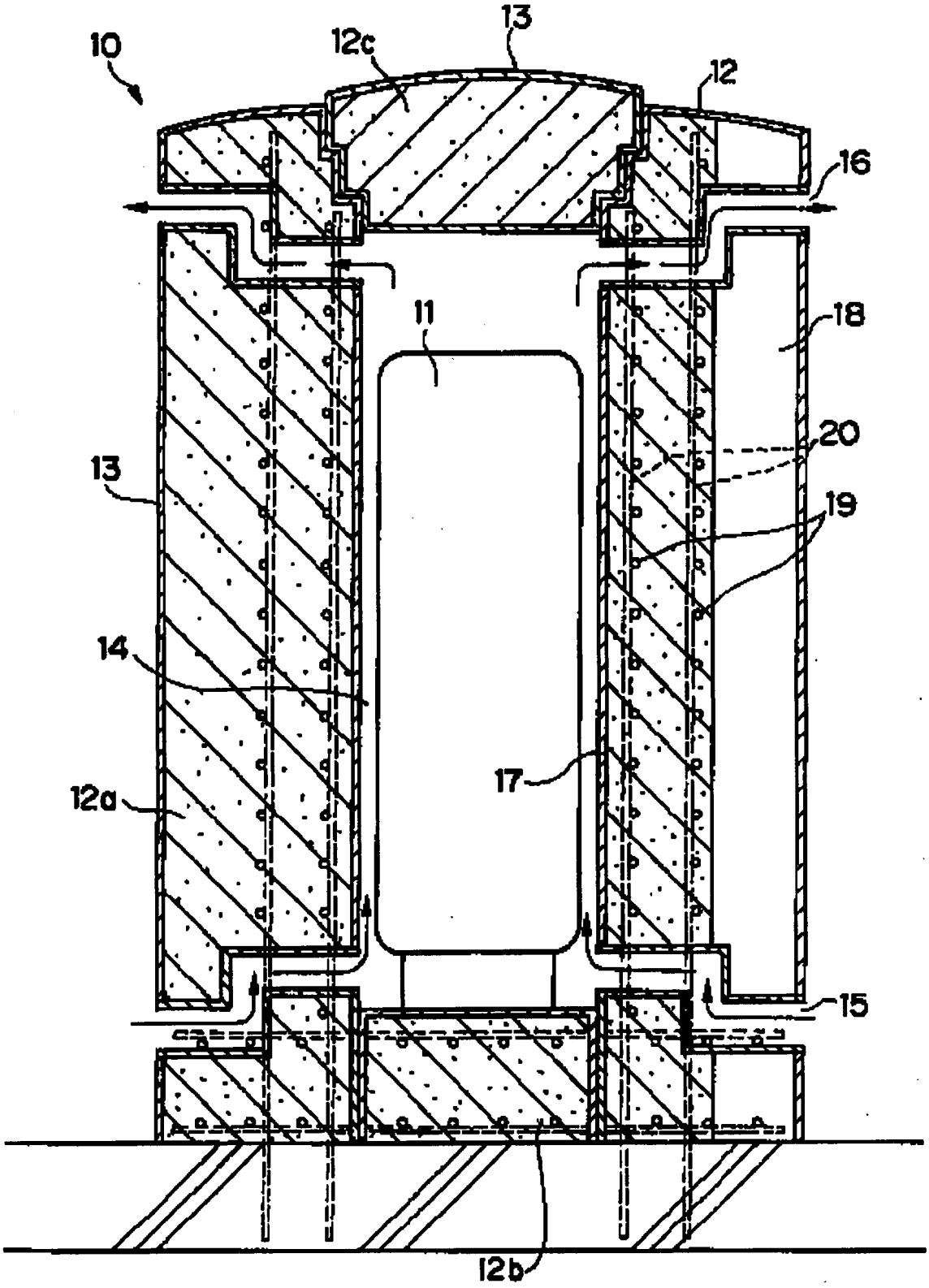
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